THE IGNEOUS ROCKS OF KANSAS.

(Prepared for the Academy in 1880, but not read until the meeting of 1881.)

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In the title adopted for this paper, the term "igneous rocks" is used to include all rocks which owe their present structural condition in any way to the agency of a high degree of heat; but we shall carefully distinguish what are usually called metamorphic from those which, like trap, appear to have been completely fused.

Throughout a region including a dozen of the northeastern counties of the State, there are places where huge boulders break through the even surface of the prairie, or are gathered into heaps of coarse gravel. These boulders, isolated or in heaps, are mostly metamorphic sandstone (quartzite), entirely unlike the bed-rock of the district in which they are found. Some of them still show their stratified structure distinctly by layers, and others are shown to be sedimentary by containing pebbles. I have not seen or heard of any that contain fossils. These rocks were undoubtedly brought here by the agency of the ice of the post-tertiary period. It would seem that they were brought from the archæan areas of Minnesota and British America. A few miles east of Manhattan, a piece of native copper (in possession of Mrs. Dr. Best, *nee* Little), was picked up which probably came from Lake Superior. At certain places in Washington, Jackson and Douglas counties, and probably other places also, there are large mounds of gravel containing the prairie hard-heads, and *other rocks foreign to Kansas*, undoubtedly brought by the same glacial agency. The writer has no doubt that these mounds are *terminal moraines* of the glacial age, and at another time may offer for consideration the facts which led to this conclusion.

The fact now of importance is, that besides the metamorphic quartzites, others of the foreign rocks are of *true igneous origin.* We have specimens of beautiful gray and red granite, of a dark hornblende rock, and a fine piece of greenstone, all taken from a deposit on the bank of Elk creek, half a mile north of Holton. In geologic phrase, these rocks are not *in situ;* or in other words, they were transported to Kansas from their native region.

As, however, they settled before Regis Loisel, and were here some scores of millenniums before Coronado's explorations, they may be fairly styled Kansas igneous rocks, and claim some notice in any disquisition on this subject. Still, in view of the age of the rocks on which the boulders are deposited, they are only new-comers—not old settlers. When they came, the Kaw river had been running for long ages, carrying down cretacean sand and mud to form our Gulf States. These stones are Kansans, precisely as we are. They are emigrants come from afar.

In that very able outline of Kansas geology, by our esteemed friend, Professor Mudge, contained in the First Biennial Agricultural Report (1877-78), we have the statement that, "There is no slate or soapstone in Kansas. They both belong to metamorphic rocks, of which we have not a single bed." (Page 70, note.) Also, that, "There is nowhere to be seen any violent disturbance of the strata, marks of internal fire, or even any slight metamorphic action in any of our deposits."

This was made in full knowledge of the transported rocks, and also of some amount of metamorphic action manifested in the lead district of the Sub-carboniferous region in the southeast corner of the State. Of that metamorphosis, however, it may be well to speak a little more fully. The solid limestone strata of Spring river and Short Creek show little or no trace of seismic agency or metamorphic action, at least as at present known. I have neither seen nor heard of trap dike or basaltic rock. The hills on which Empire City and Galena stand are, however, immense masses of brecciated material, evidently unremoved since they were brecciated. The great bulk of the material is chert or limestone of the neighboring strata, in parts somewhat silicified, and more or less altered in structure, yet with abundance of fossils scarcely changed at all. The limestone is all in angular fragments — we have looked in vain for a water-worn piece — cemented together by amber-colored zinc blende, lead ore, and iron pyrites. It appears evident that the metallic elements were in solution when forced among the debris of the limestone rocks, and into some of the interstices the mineral matter trickled so slowly as to form true crystals, and the apertures of supply becoming closed before the crevice was filled, we have the forms of the mineral crystals beautifully shown. The peculiar wedge-shaped crystals of pyrites are worthy of attention as being very suggestive.

The questions, "Whence came the mineral solutions?" "What was the degree of temperature?" and "Whence came the heat?" for the present must remain unanswered, but we venture to suggest the following as indicating the line of investigation to be carried on that should tend to answer them:

1. Was there a great downthrow of formations west of Spring river at the close of the Sub-carboniferous age? and,

2. Was the heat evolved by the friction of the fault sufficient for the fusion of metals, and solution of iron, zinc and silicon?

3. Is there in the district of Eureka Springs, or near the white marble quarries in the Indian Territory, any outburst of granite or trappeian rock whose igneous energy reached to the Galena and Joplin districts?

The only point that we make here with any degree of assurance is, that the brecciated material is, at Short Creek, on the spot where it was metamorphosed, and that, therefore, it is in a sense true that we have in Cherokee county metamorphic rock *in situ*.

About three years ago the papers of the State were agitated by reports of a silver region in Woodson county. It was said that assays made in the

East and in Colorado of ores sent from this region, showed a yield of a considerable amount of silver to the ton; but samples sent to Prof. Patrick, at Lawrence, and to Prof. Kedzie, at Manhattan, gave no such assays, and the excitement began to die out, though one or two local enthusiasts are still toiling on. Prof. Kedzie, in a report of an assay published in the *Industrialist* (Manhattan), handled the matter rather neatly, saying that he would examine, free of charge, all silver ores sent to him from that region, and expected still to have some leisure for other pursuits.

About a year and a half ago, Mr. Savage and Prof. Patrick called the writer's attention to certain specimens which had been sent to Lawrence for examination from Woodson county, and which were different from any known stratified rock in Kansas. The suggestion was that they were igneous rocks, and that possibly there was *glacial drift* further south than had hitherto been suspected. I was to visit the region and report on its geology. As I returned home, in the southeast of the State, I called on Mr. J. W. Risley, of Humboldt, and examined specimens in his possession, but was unable to visit the exact locality. I was, however, convinced a geologic investigation would reveal something of interest to science. Three months later I found an opportunity to make the journey, and this time I had the privilege of going in company with Prof. Mudge. We spent the greater part of two days examining a district not exceeding three hundred acres in area. Some weeks after that I had the opportunity to talk over the matter again with our late beloved friend; and in June last, just twelve months after my first visit, I went over the ground again, accompanied by Prof. Middaugh, of Humboldt. The second visit scarcely revealed any new fact, but largely verified former notes, and I reproduce here a portion of an article from the Chetopa *Advance*, in which I gave an account of our first visit:

"The section corner where come together sections 28, 29, 32 and 33 of township 26, range 15, east, is very near the eastern extremity of a strip about a quarter of a mile wide and very nearly a mile long, extending mostly westward from the corner stone, and mostly on the south side of the section line running between 29 and 32. A very little of the region is in section 33. This may be called the southern terminus of a ridge of high prairie, having spurs southward and a lower level both east and western ends.

"We began investigation at the west. On the surface were some quartz fragments as if they had been seams in clay. A shaft showed a limestone about two feet thick, underlaid for many feet deep with slaty shale containing some mica. The limestone had fossils. Going east the limestone changed to a dark massive-looking rock, not unlike some igneous rocks, but the traces of fossils were still plain. Instead of shale there was a loose earth under, with more mica; the rocks still horizontal. Further east a higher level is obtained, and the surface rocks are quartzose; green mostly, and dipping at a considerable angle. The loose earth is now yellower, and further east nearly black, and is rich in mica. We called it micaceous dirt. We will retain that name. North and east of the limited region we are describing, the surface rocks of the high prairie are Coal-measure sandstone, mostly reddish. Here they are all altered into quartzite, green, and some dark, blackish, olive, but many retaining their horizontal position, and the stratification plain. Others are considerably tilted up, showing violent force in a very narrow area. About the middle of the south edge of the area, and again at the eastern end, there are

masses of brecciated rock, the uniting material being quartz. Here then we have, without doubt, metamorphic rock *in situ*—quartzite and breccia. About the middle of the north edge of the area is a shaft twelve feet deep, six or eight feet long, and five feet wide. It shows the metamorphosis beautifully. A mass of white quartzite, solid (but also in part greenish, with many pores and holes filled with crystals) and wedge shape downwards, looks at first as if it were injected material lying in a fissure of the rocks; but on looking carefully we find it is a metamorphism of the immediately adjoining sandstone, which at first is barely crystaline, but which can be traced through several stages distinctly to the massive white quartzite. In places this shows contortion. We judge, then, that the metamorphic agency (heat) has been applied here from above, and under great pressure, and up to the point of fusion. This shaft yields, among other quartzose crystals, beautiful amethysts, and some that may possibly be beryl.

"The deepest shaft is that of Mr. Van Meter, which we will call No. 1. It is 70 feet deep. It has 35 feet of water in it. We descended to the surface of the water. The rocks near the surface are the altered sandstones and limestones; below is the micaceous dirt (dark colored). This is crossed in all directions by seams of dark-blue (or purplish) stone of great hardness, from one to twelve inches thick, and below the dirt is now solid, and has thin quartzose bands in it. These quartzose bands, imbedded in very fine red clay, are further developed in shaft No. 2, about two rods to the north. This blue rock and these quartz bands (only one-half inch thick) are what the miners expect will yield silver or gold. We don't. In the Pucket shaft, further east, the shale of the west end reappears with laminæ of green carbonate of copper, and near the surface is brecciated rock.

"We regard the dark-blue rock as the expression of the igneous agency. We think it is true igneous rock. We think long before other rocks were removed from the surface, this was pushed up from below into cracks and fissures, probably finding here there was no outlet, in mass; but it may have ascended in places higher than the present surface, and spreading in small caverns altered patches of rock below it, and where there was room, causing a stream of half-melted material, which inclosed the fragments which now make the breccias. Again, the action of the heated material would be likely long to have effect on the waters, and the thin veins of quartz and the crystals are probably due to infiltration in the cracks that were made as the mass cooled, while the micaceous dirt is perhaps altered shale.

"We have not here stated every fact, nor attempted to indicate all their bearings, but we have given enough to show that we have here a geological fact in Kansas not before recognized by our scientific men—metamorphic and igneous rock *in situ;* and that the time of the metamorphic eruption (which had no real outlet) was after the laying down of these Carboniferous strata, and before the denudation of superincumbent strata. Further, possibly other traces of igneous action may be found in regions where the Carboniferous strata are thinner; possibly also in Cretaceous age, and where the Carboniferous rocks are thicker."

My last interview with Prof. Mudge was when we were journeying together from Holton to Valley Falls, in July, 1879. We talked over the whole matter, and he differed from me in what I deem an important inference from the facts we both knew. Of course I was anxious that he should agree with me, and I restated the case to him as plainly as I could. He listened with his usual patience, and when we had to part he spoke words eminently characteristic, and which I shall ever remember: "Well, I don't yet see it as you do, but I may change. I shall look the whole matter over again, and I may change. Some men never change; a wise man *must* change sometimes."

While Prof. Mudge and I were at Humboldt, a gentleman told us there was a trap dike in Linn county. I undertook to visit it as early as possible. Only a short time before his death, Prof. Mudge wrote, asking me had I been to Linn county. I had not then, but in December last I made the visit. There was no trap dike.

In conclusion, we would again call to mind the statement in the biennial report, that there is no metamorphic rock in Kansas, and ask your attention to the fact that the statement was scarcely published ere the author learned that there was, and followed up the discovery with zest.

Again, the rock specimens were in the hands of experts, who examined them in reference to the question of metal or no metal, but overlooked for a time the question, What led people to think there was metal there? Prof. Patrick, who has also visited Silver City, in Woodson county, pronounces that half-mile of land the most remarkable mineral district he has ever visited; and I, thinking the same, do not wonder that some uneducated men, seeing indications very like what we see in Colorado, should have become infatuated with the idea of finding the precious metals. They see resemblances—a lack of geological knowledge hinders them detecting differences.

Why do I mention these things? To suggest that if our State was thoroughly surveyed geologically, local reports could be investigated by a competent official before time and money were wasted in useless enterprises, and very probably knowledge would be obtained that could direct capital into useful and remunerative undertakings.

Further, we would suggest to local geologists to look out for signs of metamorphism and trap dikes. In other parts of the world to-day, and also in the geological ages, there have been igneous overflowings without extensive fracture, and this was not unknown in the Cretaceous period. These would cause local metamorphism and peculiar mineral conditions. Let the geologists of Labette, Cowley and other counties, besides looking for fossils and the line of outcrop, look also for crystaline structure and local faults, till we know more fully than we know now the Igneous Rocks of Kansas.

ARE THERE IGNEOUS ROCKS IN CHEROKEE COUNTY?

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In the March number of the *Kansas City Review of Science and Industry*, the writer published an article entitled, "The Chert Rocks of Sub-carboniferous Kansas." In this article two points are particularly insisted upon: First, that the chert rocks have been deposited in layers, are true stratified rocks, and are not metamorphosed limestone; second, that there is not only no indication of volcanic action among those rocks, but that there is positive evidence to the contrary. It is also held that the reason given by Dr. Schmidt,